Patent Claims

1. External electrodes (3, 4, 8) on piezoceramic multilayer actuators (1), composed of a layer of a basic metallization (3) applied to the ceramic material (2) of the surface of the actuator (1), to which metallization there is joined by means of a joining layer (8) a reinforcing layer (4) to which a connecting wire (5) is soldered, characterized in that the layer of basic metallization (3) is structured (15) by discontinuities or recesses (17).

2. External electrodes according to Claim 1, characterized in that the structure (15) of the basic metallization (3) is composed of a printed pattern of a suitable termination paste, which printed pattern has been produced by means of a printing method.

3. External electrodes according to Claim 1, characterized in that the structure (15) of the basic metallization (3) is formed by a mechanical, chemical or electrochemical removal in a layer of the basic metallization (3) applied over the entire area.

4. External electrodes according to Claim 2 or 3, characterized in that the basic metallization (3) is composed of a suitable termination paste that has the composition Ag_xPd_y, where $x + y = 1$ and $1 > x > 0$, but preferably $1 > x > 0.7$.

5. External electrodes according to Claim 1, characterized in that the structure (15) of the

basic metallization (3) is formed by a porous electrochemical deposition of a suitable metallic material.

6. External electrodes according to Claim 5, characterized in that the metallic material is nickel.

7. External electrodes according to one of Claims 1 to 6, characterized in that the structure (15) of the basic metallization (3) is composed of areas (16) disposed over the surface of the actuator (1) and in that the areas (16) are at least large enough for respective adjacent internal electrodes (10) to be joined together by at least one area (16).

8. External electrodes according to one of Claims 1 to 7, characterized in that the structure (15) of the basic metallization (3) is composed of dots, in that the diameter of the dots (16) is equal to 0.5 to 5 times the thickness of the ceramic layers (2) of the actuator (1), in that the minimum distance (17) between the dots (16) is likewise equal to 0.5 to 5 times the thickness of the ceramic layers (2) of the actuator (1), and in that a straight line extending through the dots (16) encloses an angle (18) with respect to the path of the internal electrodes (10) that is approximately between 10 degrees and 80 degrees, preferably between 15 degrees and 40 degrees.

9. External electrodes according to Claim 8, characterized in that the diameter of and the spacing (17) between the dots (16) are equal to two

to three times the thickness of the ceramic layers (2) of the actuator (1).

10. External electrodes according to one of Claims 1 to 7, characterized in that the structure (15) of the basic metallization (3) is composed of parallel lines (16), in that the width of the lines (16) is equal to 0.5 to 5 times the thickness of the ceramic layers (2) of the actuator (1), in that the minimum distance (17) between the lines (16) is likewise equal to 0.5 to 5 times the thickness of the ceramic layers (2) of the actuator (1), and in that the lines (16) enclose an angle (18) with respect to the path of the internal electrodes (10) that is approximately between 10 degrees and 80 degrees, preferably between 15 degrees and 40 degrees.

11. External electrodes according to Claim 10, characterized in that the width of and the spacing (17) between the lines (16) are equal to 2 to 3 times the thickness of the ceramic layers (2) of the actuator (1).

12. External electrodes according to one of Claims 1 to 7, characterized in that the structure (15) of the basic metallization (3) is composed of lines (16) disposed in grid-type manner, in that the width of the lines (16) is equal to 0.5 to 5 times the thickness of the ceramic layers (2) of the actuator (1), in that the minimum distance (17) between the lines (16) is likewise equal to 0.5 to 5 times the thickness of the ceramic layers (2) of the actuator (1), and in that the lines (16) of the grid (15) are at a random angle (18) with respect to one

another and to the path of the internal electrodes (10).

13. External electrodes according to Claim 12, characterized in that the width of and the spacing (17) between the lines (16) are equal to 2 to 3 times the thickness of the ceramic layers (2) of the actuator (1).

14. External electrodes according to one of the preceding claims, characterized in that the joining layer (8) between basic metallization (3) and reinforcing layer (4) is composed of a solder that contains at least one of the metals Sn, Ag, Cu, Pb, Au, In, Ga.

15. External electrodes according to Claim 14, characterized in that the solder is a tin-containing material, preferably $SnAg_4$ or $SnCu_{0.7}$.

16. External electrodes according to one of the preceding claims, characterized in that the joining layer (8) between basic metallization (3) and reinforcing layer (4) is an electrically conductive adhesive.

17. Method for producing external electrodes according to one of Claims 1 to 16, characterized in that the layer of the basic metallization is structured by discontinuities and recesses.

18. Method according to Claim 17, characterized in that the structure of the basic metallization is produced as a printed pattern by means of a printing method using a suitable termination paste.

19. Method according to Claim 17, characterized in that the structure of the basic metallization is formed by a mechanical, chemical or electrochemical removal in a layer of the basic metallization applied over the entire area.

20. Method according to Claim 18 or 19, characterized in that the basic metallization is produced from a suitable termination paste that has the composition Ag_xPd_y, where $x + y = 1$ and $1 > x > 0$, but preferably $1 > x > 0.7$.

21. Method according to Claim 17, characterized in that the structure of the basic metallization is formed by a porous electrochemical deposition of a suitable metallic material.

22. Method according to Claim 21, characterized in that nickel is used as metallic material.

23. Method according to one of Claims 17 to 22, characterized in that the structure of the basic metallization is formed from areas distributed over the surface of the actuator and in that areas are produced that are at least large enough for respectively adjacent internal electrodes to be joined together by at least one area.

24. Method according to one of the preceding claims, characterized in that the reinforcing layer is soldered onto the basic metallization, and in that the solder contains at least one of the metals Sn, Ag, Cu, Pb, Au, In, Ga.

25.Method according to Claim 24, characterized in that the solder is a tin-containing material, preferably $SnAg_4$ or $SnCu_{0.7}$.

26. Method according to Claim 24 or 25, characterized in that metal from the solder is alloyed into the internal electrodes by the discontinuities in the structure of the basic metallization, and in that the ceramic material is weakened at these points, as a result of which preferred points are formed for possible crack formation and the crack path.